

the TV signal resolution to drop, and achieving the three-dimensional graceful degradation effect shown in FIG. 153 and unobtainable with conventional methods. As shown in FIG. 153, the three-dimensional multilevel broadcast structure of the invention is achieved with three parameters: C/N ratio, multipath delay time, and the transmission rate.

The present embodiment has been described using the example of a two-dimensional multilevel broadcast structure obtained by combining GTW-OFDM of the invention with C-CDM of the invention as previously described, or combining GTW-OFDM, CSW-C-CDM, but other two-dimensional multilevel broadcast structures can be obtained by combining GTW-OFDM and power-weighted OFDM, or GTW-OFDM with other C/N ratio multilevel transmission methods.

FIG. 154 is obtained by transmitting the power of carriers 794a, 794c, and 794e with less weighting compared with carriers 794b, 794d, and 794f, achieving a two level power-weighted OFDM. Two levels are obtained by power weighting carriers 795a and 795c, which are perpendicular to carrier 794a, to carriers 795b and 795d. While a total of four levels are obtained, the embodiment having only two levels is shown in FIG. 154. As shown in the figure, because the carrier frequencies are distributed, interference with other analog transmissions on the same frequency band is dispersed, and there is minimal adverse effect.

By using a time positioning varying the time width of guard times 797a, 797b, and 797c for each symbol 796a, 796b, and 796c as shown in FIG. 155, three-level multipath multilevel transmission can be achieved. Using the time positioning shown in FIG. 155, the A-, B-, and C-level data is distributed on the time axis. As a result, even if burst noise produced at a specific time occurs, data destruction can be prevented and the TV signal can be stably demodulated by interleaving the data from the different layers. In particular, by interleaving with the A level data distributed, interference from burst noise generated by the ignition systems of other vehicles can be significantly reduced in mobile TV receivers.

Block diagrams of a specific ECC encoder 744j and a specific ECC decoder 749j are shown in FIG. 160a and FIG. 160b, respectively. FIG. 167 is a block diagram of the deinterleaver 936b. The interleave table 954 processed in the deinterleaver RAM 936a of the deinterleaver 936b is shown in FIG. 168a, and interleave distance LI is shown in FIG. 168b.

Burst noise interference can be reduced by interleaving the data in this way. By using a 4-level VSB, 8-level VSB, or 16-level VSB transmission apparatus as described in embodiments 4, 5, and 6, respectively, and shown in the VSB receiver block diagram (FIG. 161) and the VSB transmitter block diagram (FIG. 162), or by using a QAM or PSK transmission apparatus as described in embodiments 1 and 2, respectively, burst noise interference can be reduced, and television reception with very low noise levels can be achieved in ground station broadcasting.

By using 3-level broadcasting by means of the method shown in FIG. 155, LDTV grade television reception by mobile receivers, including mobile TV receivers in motor vehicles and hand-held portable television sets, can be stabilized because level A has the effect of reducing burst noise interference in addition to multipath interference and C/N ratio deterioration.

The multi-level signal transmission method of the present invention is intended to increase the utilization of frequencies but may be suited for not all the transmission systems since causing some type receivers to be declined in the

energy utilization, it is a good idea for use with a satellite communications system for selected subscribers to employ most advanced transmitters and receivers designed for best utilization of applicable frequencies and energy. Such a specific purpose signal transmission system will not be bound by the present invention.

The present invention will be advantageous for use with a satellite or terrestrial broadcast service which is essential to run in the same standards for as long as 50 years. During the service period, the broadcast standards must not be altered but improvements will be provided time to time corresponding to up-to-date technological achievements. Particularly, the energy for signal transmission will surely be increased on any satellite. Each TV station should provide a compatible service for guaranteeing TV program signal reception to any type receivers ranging from today's common ones to future advanced ones. The signal transmission system of the present invention can provide a compatible broadcast service of both the existing NTSC and HDTV systems and also, ensure a future extension to match mass data transmission.

The present invention concerns much on the frequency utilization than the energy utilization. The signal receiving sensitivity of each receiver is arranged different depending on a signal state level to be received so that the transmitting power of a transmitter needs not be increased largely. Hence, existing satellites which offer a small energy for reception and transmission of a signal can best be used with the system of the present invention. The system is also arranged for performing the same standards corresponding to an increase in the transmission energy in the future and offering the compatibility between old and new type receivers. In addition, the present invention will be more advantageous for use with the satellite broadcast standards.

The multi-level signal transmission method of the present invention is more preferably employed for terrestrial TV broadcast service in which the energy utilization is not crucial, as compared with satellite broadcast service. The results are such that the signal attenuating regions in a service area which are attributed to a conventional digital HDTV broadcast system are considerably reduced in extension and also, the compatibility of an HDTV receiver or display with the existing NTSC system is obtained. Furthermore, the service area is substantially increased so that program suppliers and sponsors can appreciate more viewer. Although the embodiments of the present invention refer to 16 and 32 QAM procedures, other modulation techniques including 64, 128, and 256 QAM will be employed with equal success. Also, multiple PSK, ASK, and FSK techniques will be applicable as described with the embodiments.

A combination of the TDM with the SRQAM of the present invention has been described in the above. However, the SRQAM of the present invention can be combined also with any of the FDM, CDMA and frequency dispersal communications systems.

What is claimed is:

1. A digital TV receiver comprising:

- a receiving section for receiving a PSK (Phase Shift Key) modulation signal comprising a plurality of signal points disposed on specific phases of a given constellation in a signal space diagram;
- a demodulator for demodulating the received signal from said receiving section into a digital signal;
- an error correcting section for error correcting a demodulation signal from said demodulator; and
- an image expander for expanding an error-corrected signal from said error correcting section to a video signal, thereby outputting a video signal.

wherein said demodulator demodulates the received signal as first and second PSK signals, said first PSK signal representing a first data stream to be reproduced, said first PSK signal comprising  $n$ -value signal points, said second PSK signal representing both said first data stream and a second data stream to be reproduced, said second PSK signal comprising  $m$ -value signal points, where  $m$  is an integer larger than  $n$ ,

wherein the  $m$ -value signal points of said second PSK signal are divisible into  $n$  groups of signal points which are distinguishable from one another in the signal space, and said demodulator distinguishes said  $n$  groups of signal points from one another as the  $n$ -value signal points of said first PSK signal by demodulating the received signal as said first PSK signal, and wherein

high priority information is demodulated at least in said first data stream.

2. The digital TV receiver in accordance with claim 1, wherein said demodulator demodulates information relating to a low-resolution component of the video signal from said first data stream and demodulates information relating to a high-resolution component of the video signal from said second data stream.

3. The digital TV receiver in accordance with claim 1, comprising means for stopping output of said second data stream when an error rate of the received signal is high.

4. The digital TV receiver in accordance with claim 1, wherein said demodulator comprises first means for

demodulating the received signal as a QPSK signal to reproduce the first data stream and second means for demodulating the received signal as a 8PSK signal to reproduce both of the first data stream and the second data stream.

5. A digital TV receiver comprising:

a receiving section for receiving a PSK (Phase Shift Key) modulation signal comprising  $m$ -value signal points disposed on specific phases of a given constellation in a signal space diagram and representing a first data stream and a second data stream to be reproduced;

a demodulator for demodulating said PSK modulation signal from said receiving section into a digital signal; an error correcting section for error correcting a demodulation signal from said demodulator; and

an image expander for expanding an error-corrected signal from said error correcting section to a video signal, wherein said demodulator includes means for demodulating said PSK signal comprising  $m$ -value signal points as another PSK signal,

said another PSK signal comprising  $n$ -value signal points and representing only said first data stream, where  $n$  is an integer smaller than  $m$ , and wherein

high priority information is demodulated at least in said first data stream.

\* \* \* \* \*

ADD 92

~~ADD 91~~